

**MULTIMEDIA**



**UNIVERSITY**

**STUDENT ID NO**

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# MULTIMEDIA UNIVERSITY

## FINAL EXAMINATION

TRIMESTER 2, 2018/2019

### TIC2151 THEORY OF COMPUTATION/ TCS3511 THEORY OF COMPUTING

(All sections / Groups)

09<sup>th</sup> March 2019  
9.00 am – 11.00 am  
(2 Hours)

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#### INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 3 pages only excluding the cover page.
2. Attempt all questions. The distribution of the marks for each question is given.
3. Please write your answers in the answer booklet provided. Please write the question number of each answer clearly.

**QUESTION (1)**

**NOTE: Attempt any THREE out of FOUR Parts (A), (B), (C) and (D).**

(A)

1. What is *automata theory*? [2 marks]
2. Prove the following by construction: [3 marks]

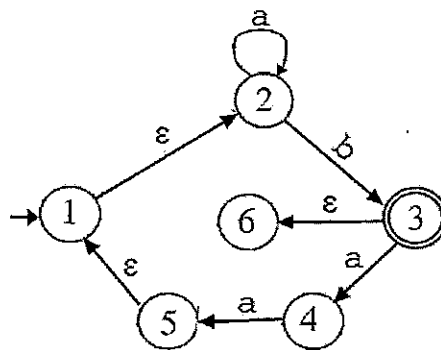
"If  $a, b$  are integers, the product  $ab$  is odd if  $a$  and  $b$  are both odd"

(B) Draw state diagrams for DFAs accepting the following languages:

$L_1 = \{w \in \{a, b\}^* \mid w = a(aab)^n, n \geq 0\}$  [2.5 marks]

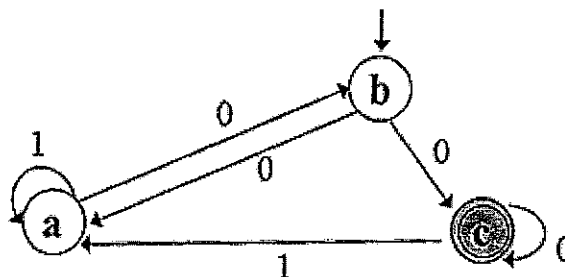
$L_2 = \{w \in \{a, b\}^* \mid w \text{ has either } aa \text{ or } bb \text{ as a substring}\}$  [2.5 marks]

(C) Convert the following NFA into an NFA without  $\epsilon$ -transitions. Show the transition table and the corresponding state diagram. [5 marks]



(D)

Convert the following NFA into a DFA. Then minimize the obtained DFA. Show your steps. [5 marks]



**QUESTION (2)**

(A)

1. Determine the language corresponding to each of the following regular expressions:

i.  $0^*10^*10^* + 1^*01^*01^*$  [1.5 marks]

ii.  $aa(a+b)^*(ab+ba)$  [1.5 marks]

2. Find regular expressions corresponding to each of the following languages.

i.  $L = \{ w \mid w \text{ not containing the substring } 00 \}$  [2 marks]

ii.  $L = \{ w \in \{0, 1\}^* \mid \text{the length of } w \text{ is 2 or 4} \}$

- (B) Convert the following regular expression into an NFA. Follow the construction rules closely and do not just give a simpler NFA even though it is possible.

$$(0+1)^*(0+1)^* \quad [5 \text{ marks}]$$

(C)

1. Convert the following regular grammar into an NFA. [2 marks]

$$\begin{aligned} Q &\rightarrow aR \\ R &\rightarrow bR \mid aS \\ S &\rightarrow bT \mid aV \\ T &\rightarrow R \mid \varepsilon \\ V &\rightarrow bV \end{aligned}$$

2. Give the regular grammars corresponding to each of the following languages over the alphabet  $\{a, b\}$ .

$$L_1 = (ab^*ab)^+ \quad [1.5 \text{ marks}]$$

$$L_2 = a(ba)^*b^* \quad [1.5 \text{ marks}]$$

**QUESTION (3)**

- (A) Construct a PDA over the alphabet  $\{a, b, c\}$  for each of the following languages:

$$L_1 = \{ba^n b^{2n} a^2 \mid n > 0\} \quad [3 \text{ marks}]$$

$$L_2 = \{a^n b^{n+m} c^m \mid n, m \geq 1\} \quad [3 \text{ marks}]$$

- (B) Give the context-free grammars for each of the following languages

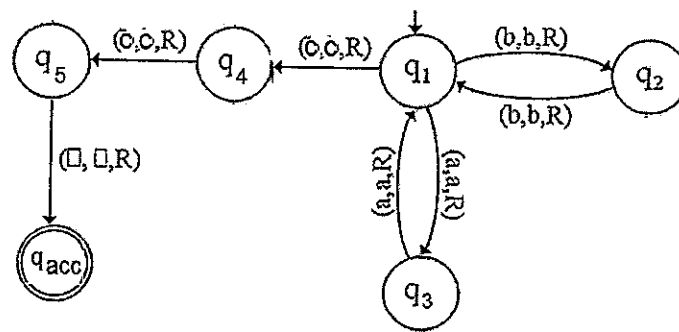
$$L_1 = \{w \in \{0, 1\}^* \mid w \text{ starts and ends with the same digit}\} \quad [2 \text{ marks}]$$

$$L_2 = \{0^n 1^n \mid n \geq 1\} \cup \{1^n 0^n \mid n \geq 1\} \quad [2 \text{ marks}]$$

**QUESTION (4)**

**NOTE: Attempt any TWO out of THREE Parts (A), (B) and (C).**

- (A) Given the following Turing Machine:



- What language does the machine accept? Give the language in regular expression form. [1 mark]
  - Give the formal definition of the machine including the transition table. [4 marks]
- (B) Construct a Turing Machine for the language  $L = \{a^n b a^m \mid 0 \leq n \leq m\}$ . [5 marks]
- (C) A language  $L$  is TM-decidable if there exists a TM  $M$  that can decide it. Consider the language:

$$A_{TM} = \{\langle M, w \rangle \mid M \text{ is a TM and } M \text{ accepts the input } w\}$$

Prove by contradiction that the language  $A_{TM}$  is not TM decidable. [5 marks]

**End of page.**

